



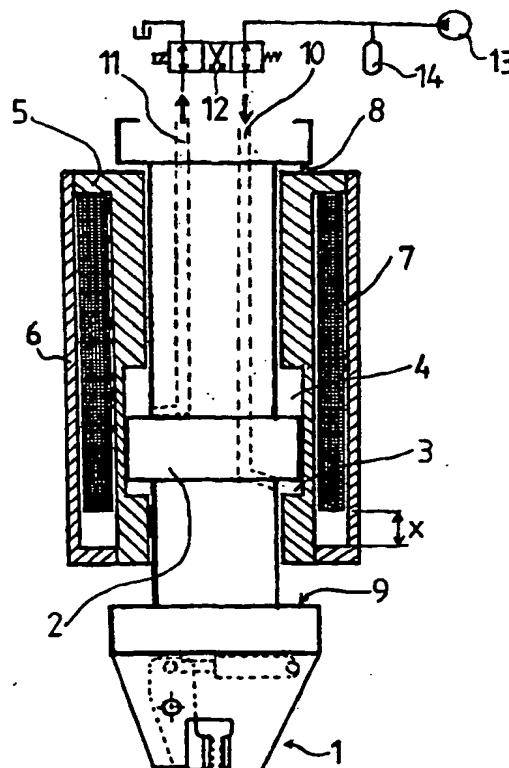
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>B25D 9/04, 17/24, E21B 7/20, E02D 7/10</b>		A1	(11) International Publication Number: <b>WO 97/04926</b>
			(43) International Publication Date: 13 February 1997 (13.02.97)
(21) International Application Number: PCT/FI96/00425 (22) International Filing Date: 31 July 1996 (31.07.96) (30) Priority Data: 953636                      31 July 1995 (31.07.95)                      FI 960434                      30 January 1996 (30.01.96)                      FI (71) Applicant (for all designated States except US): RAUNISTO, Airi [FI/FI]; Anttilankatu 13, FIN-13210 Hämeenlinna (FI). (72) Inventor; and (75) Inventor/Applicant (for US only): RAUNISTO, Yrjö [FI/FI]; Anttilankatu 13, FIN-13210 Hämeenlinna (FI). (74) Agent: NIEMINEN, Taisto; Patenttitoimisto T. Nieminen Oy, Kehräsaari B, FIN-33200 Tampere (FI).			(81) Designated States: JP, KR, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>In English translation (filed in Finnish).</i>

(54) Title: A DEVICE PERFORMING HAMMERING BY MEANS OF HYDRAULIC PRESSURE

## (57) Abstract

A device generating strokes by hydraulic pressure optionally in two directions and having a to- and from moving piston (5), the travel of which is maintained in steering the hydraulic pressure by means of a reversing valve (12) to produce effect upon transverse faces formed in the piston and the opposite ends of which piston (5), work as strokes transmitting faces. Piston (5, 19) is a ring-shaped piston, in the annular space of which a cylinder space (4, 26) is formed into which at least a portion of the stroke-transmitting body (2, 22) that functions as attachment body for a tool (1) or for the target objects (25) is placed.



**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

# A DEVICE PERFORMING HAMMERING BY MEANS OF HYDRAULIC PRESSURE

The invention relates to a device generating strokes by a piston with linear travel according to the introductory chapter of patent claim 1.

Previously known are, for instance from the Finnish patent application 935536, devices generating strokes by means of rotating eccentric masses. Optionally, the strokes can be directed in two directions, in practice downward or upward. Using several rotating masses the impact of stroke can be directed quite sharply in a wanted direction. Instead of compensation masses, some degree of the impact of stroke remains in the opposite direction. On driving profiles with such a device into the ground, the stroke is directed quite sharply and therefore by short duration on the profile. With the stroke starting friction, dynamic friction and possible repercussion of profile must be overcome.

Further, from the Finnish application 843015 a hydraulic percussion hammer is known, where the piston is accelerated into motion by hydraulic pressure in order to strike the percussion-transmitting construction. Also in this construction only one stroke is generated at a time and one strives to absorb the impact of stroke by means of moving mass containing also a cylinder space for the piston.

In connection with percussion devices absorption pieces are known, by means of which the stroke is transmitted absorbed and timely by some longer duration to the profile. As such elements wooden intermediate pieces are used, among others. Using absorption pieces the stroke is transferred as one impulse into the profile. The absorption can then be so great that the starting friction of profile cannot be overcome and the stroke remains ineffective. On the other hand, instead of

absorption, the duration of stroke can remain so short that the impact of stroke stops before repercussion of profile and the profile does not, necessarily, be driven forward by the stroke.

On driving long objects into the ground, the percussion device must be lifted up quite high over the top of the object and while the stroke advances, the device must be lowered again. This job calls for an outreaching crane and a complicated starting, whereby a long object, for instance a pile, is first erected using auxiliary equipment. Not only by gripping the pile from its top can the percussion device lift a long pile into up-right position from the ground.

In order to solve the above presented problems a new percussion device is presented, which is characterized in what is disclosed in the patent claims.

The advantage of the invention is a new type two-stage or multistage impact of stroke, at the shock peak of which initial stage the target object is "provoked" into motion or at least into a condition of vibration which, in the first place, corresponds to overcoming the starting friction. By means of the construction the timing of the shock peak can be adjusted immediately after the former peak so that the object is still moving or in condition of vibration and the starting friction overcome. By these proceedings the impact of the latter shock peak is used as completely as possible for forward travel of the object.

By means of the annular piston and the percussion device percussion of profiles in low spaces is improved, when the percussion device is, instead of the profile top, about in the middle section of the profile and not increasing the total height. By means of a hydraulic excavator long piles, beams

and profiles can be driven in case the excavator outreach does not become a restriction. Percussion of thin-walled and easy-buck-ling profiles is possible when, in changing the grip, percussion can always be carried out close to the ground level. Lifting profiles from ground is possible with an excavator by replacing the scoop with a percussion device, which can be tilted as the scoop and the profile can be gripped by the percussion device about from its middle, whereat the outreach of the excavator becomes more sufficient.

In the following the invention is disclosed with reference to the enclosed drawing where

Fig. 1 is a percussion device with an outside piston and a moving mass inside of it as a cross-section.

Fig. 2 is a mass with moving secondary mass.

Fig. 3 is a liquid mass.

Fig. 4 is a percussion device with an opening through its centre.

Figure 1 shows a hydraulic percussion device that has as inner part a ram 2 furnished with an annular shoulder 2, from which the strokes are transmitted to one of the longitudinal directions. Shoulder 2 around the ram has a travel distance between the stop faces in the piston 5. The upper part of the ram is a flange with a shoulder 8, against whose annular face piston 5 hits its upward strokes. The lower part of ram 8 has a flange against whose stop face 9 piston 5 hits its downward strokes. The lower part of the ram has a pile-beating head 1 with gripping jaws, illustrated in this example as a possible percussion tool.

Inside piston 5 a cylinder space is formed, into which hydraulic pressure is conveyed. The rod has a shoulder 2 dividing the cylinder into two parts 3 and 4 and transmitting axial force to the rod.

The to-and-fro motions of piston 5 are achieved by a control system with a valve 12 that by means of electric steering turns most suitably the feeding direction of the hydraulic liquid to channels 10 and 11. Valve 12 has a reversing function adjusted to work by observing the piston position each time. The pressure source is a pump 13 and to the pressure line a hydraulic accumulator 14 is attached to ensure the speed of piston travel in order to produce accelerating motion for the piston and to reduce the effect of pressure shocks in the system.

The device in figure 1 is furnished with a piston, according to the invention, which has an annular free space inside of which a mass 7 is moving. Mass 7 is a solid ring, for which a free travel space as big as distance X has been arranged with regard to the piston. Piston 5 is accelerated to strike downward in steering pressure into chamber 4. In using a hydraulic accumulator 14, the stroke can be made to accelerate and for the piston a sufficient final velocity achieved before it hits shoulder 9. Mass 7 follows piston 5 and produces in the second stage its own stroke on the lower part of piston 5 already leaning against shoulder 9. The mass is solid, for instance of steel or lead, and the piston comprised of several parts, for instance a separate outer shell 6, for assembly reasons. In one embodiment the mass can also be a ring totally outside the piston and its length and thickness easily adjusted and, accordingly, the travel distance X and the amount of mass as well.

In the inventional embodiment the second stage stroke takes place with a delay that it takes the mass 5 to travel distance X. The device produces two successive sharp strokes, whereby the first stroke makes the target profile move and the second stroke produces driving impact. In this basic embodiment there are no absorptions. The time between the successive strokes is

adjusted in changing the travel distance X or the piston speed. The mass hits the piston while the target profile is moving or in the condition of vibration caused by the stroke.

For instance, in one embodiment to the solution as per figure 1 absorption elements are added to shoulder 9, whereby the effective time of the stroke of both stages is lengthened. As absorbing pieces for instance wooden pieces known as such are used.

In another embodiment in the moving mass 7 a space is formed for a secondary mass 15, which has a travel distance X' of its own inside mass 7 as shown in figure 2 and this mass 15 strikes with delay even after mass 7.

In the fourth embodiment the mass is liquid 16 as per figure 3. The liquid motion can be delayed by chokers 17, whereat the pressure stroke can also be delayed. On the other hand, the chokers may slow down the flow of liquid even during return travel, but the effect is small if the choking point is close to the stroke wall, in this case the piston lower edge. As liquid water, mercury or other heavy liquids can be used. Instead of liquid the mass can be granulitic, whereby the stroke becomes distinctly absorbed, for instance compared with a solid mass, already without any retarders. Used granulated material can be electrically charged, whereat a steered motion of the granulated material is achieved, for instance pulling and pushing towards the piston head, and it is possible to produce effect on the return travel of the granulated material or its motion in the stroke direction.

Along with the return travel of the piston, the mass 7, 16 or masses 7 and 15 shift over to the piston upper part, where they arrive not later than by the delay, which it takes them according to the law of continuity, when the piston has

already stopped in the upper position or the corresponding upper turning point. When the mass hits the piston upper part, it is due time to start the piston travel for a new stroke. Steering of valve 12 is carried out with this delay. After the stroke, the piston return travel is started when the mass or the masses have hit the piston lower part.

By means of combinations of the above embodiments and also by adding absorptions a solution is reached, where the two successive sharp strokes as per the first embodiment are changed into a stroke of longer duration. Of course, by a construction according to the invention different, properly timed and properly formed stroke profiles can be produced.

The device in figure 1 can be steered to strike according to the invention also in the opposite direction only by changing the control of valve 12. Tool 1 can also be replaced by other striking tools, as for instance a striking pike.

Figure 4 shows a percussion device with an annular body 22. The percussion profile, as tube 25, is placed from the opening running through the body, whereby the percussion device is located around the the profile. The percussion device has a ring shaped piston 19 moving to-and-fro. The alternating piston motions are achieved by means of the control system as per figure 1. It is possible to strike in both directions with the piston.

The percussion profile 25 is centrally inside the body 22. The profile is attached with movable wedges 20, which press against the profile body 22. The wedges 20 are moved for instance by means of hydraulic cylinders 21. The strokes of piston 19 increase the wedge effect and the percussion profile sticks reliably to the body.



The form of the wedge pieces can alterate according to the profiles so that it is possible to strike different kinds of profiles, tubes, piles, beams etc only in changing wedge pieces.

If the profile is about to buckle or yields at the wedges, as a support for profile 1, for instance inside the profile by the wedges, a support element 23 can be installed, which is tightened or expanded by some power unit, for instance a hydraulic cylinder 24. The support can be placed or moved into a required location by a wire rope or a winch.

The percussion device is by means of rubber pillows attached to the outer body of the percussion body 27. The outer body is attached to the excavator in place of the scoop.

## PATENT CLAIMS

A device generating strokes by hydraulic pressure optionally in two directions and having a to-and fro moving piston (5), (19), the travel of which is maintained in steering the hydraulic pressure by means of a reversing valve (12) to produce effect upon transverse faces formed in the piston and the opposite ends of which piston (5), (19) work as stroke transmitting faces, **characterized in** that the piston (5), (19) is a ring-shaped piston, in the annular space of which a cylinder space (3,4), (26) is formed into which at least a portion of the stroke-transmitting body (2), (22) that functions as attachment body for a tool (1) or for the target objects (25) is placed.

2. A device according to patent claim 1 **characterized in** that the device centre is open for placing long objects (25), which are to be driven, through the device into stroke-taking position.

3. A device according to patent claims 1 and 2 **characterized in** that there are in the body (22) fixing elements (20,21) for attachment of the percussion device around an object (25) taken through the device.

4. A device according to any of the above patent claims 1-3 **characterized in** that piston (5) comprises a mass (7), (15), (16) assembled to move a limited distance in the percussion direction with regard to the piston, which mass is matched to accelerate with the stroke travel along with the piston, most suitably pushed by the piston, and that for the said mass a play (X) in the percussion direction is arranged so that it would not hit the travel stopper before the piston has accomplished its stroke.

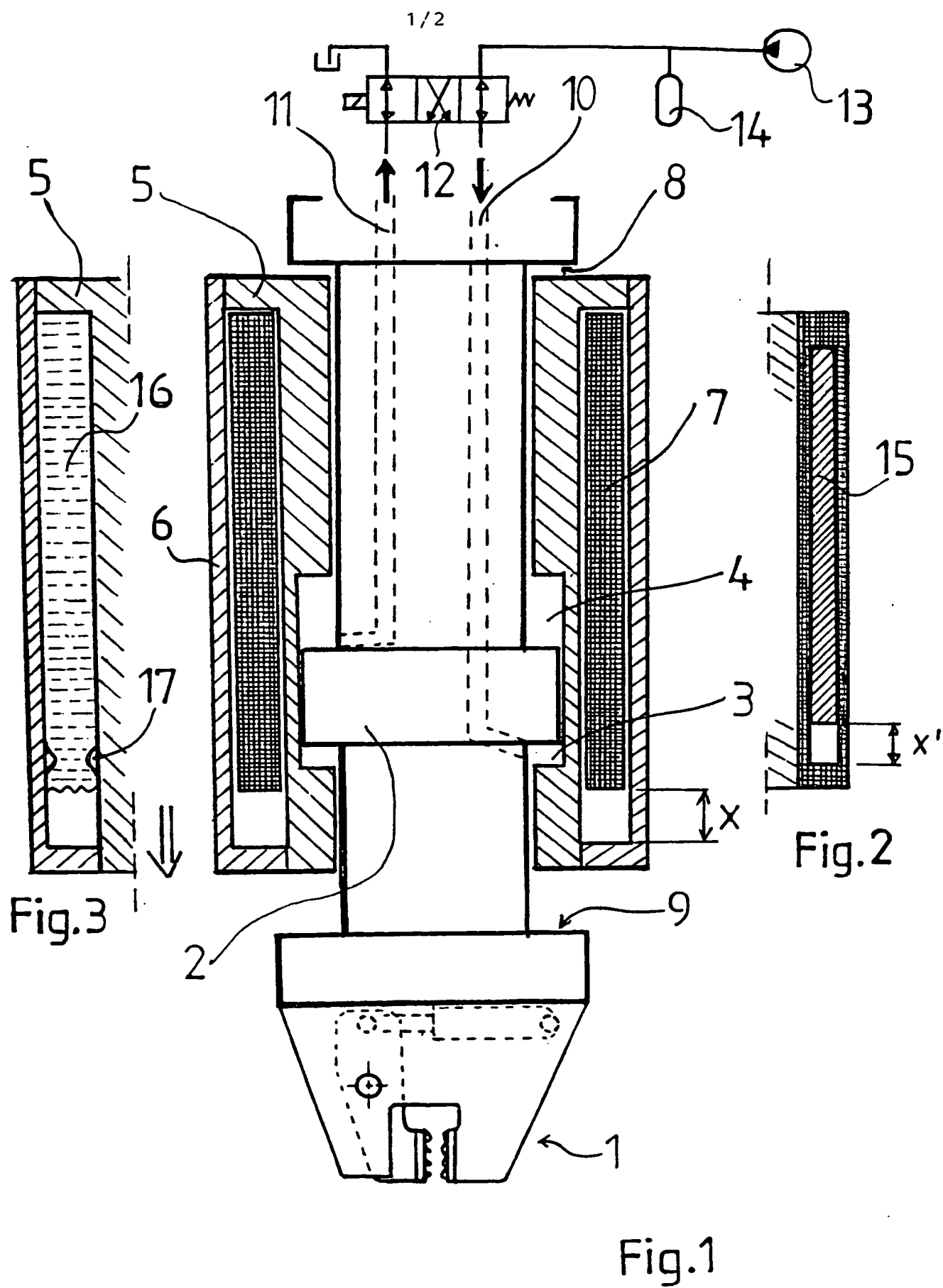
5. A device according to any of the above patent claims 1-4 **characterized in** that the mass is an annular piece outside the piston.

6. A device according to any of the above patent claims 1-5 **characterized in** that the mass is a liquid (16), granular or solid (7) mass arranged inside the piston.

7. A device according to any of the above patent claims 1-6 **characterized in** that in connection with the mass there are absorption means in order to prolong the effective time of stroke caused by the mass.

8. A device according to any of the above patent claims 1-7 **characterized in** that there are braking means 17 for the liquid or the granulated mass to brake their movement at least in the direction of percussion.

9. A device according to any of the above patent claims 1-8 **characterized in** that distance (X) has been chosen so small that the stroke of mass (7) on piston (5) takes place when the stroke target (1,2) is in a condition of vibration generated by the preceding piston (5) stroke.



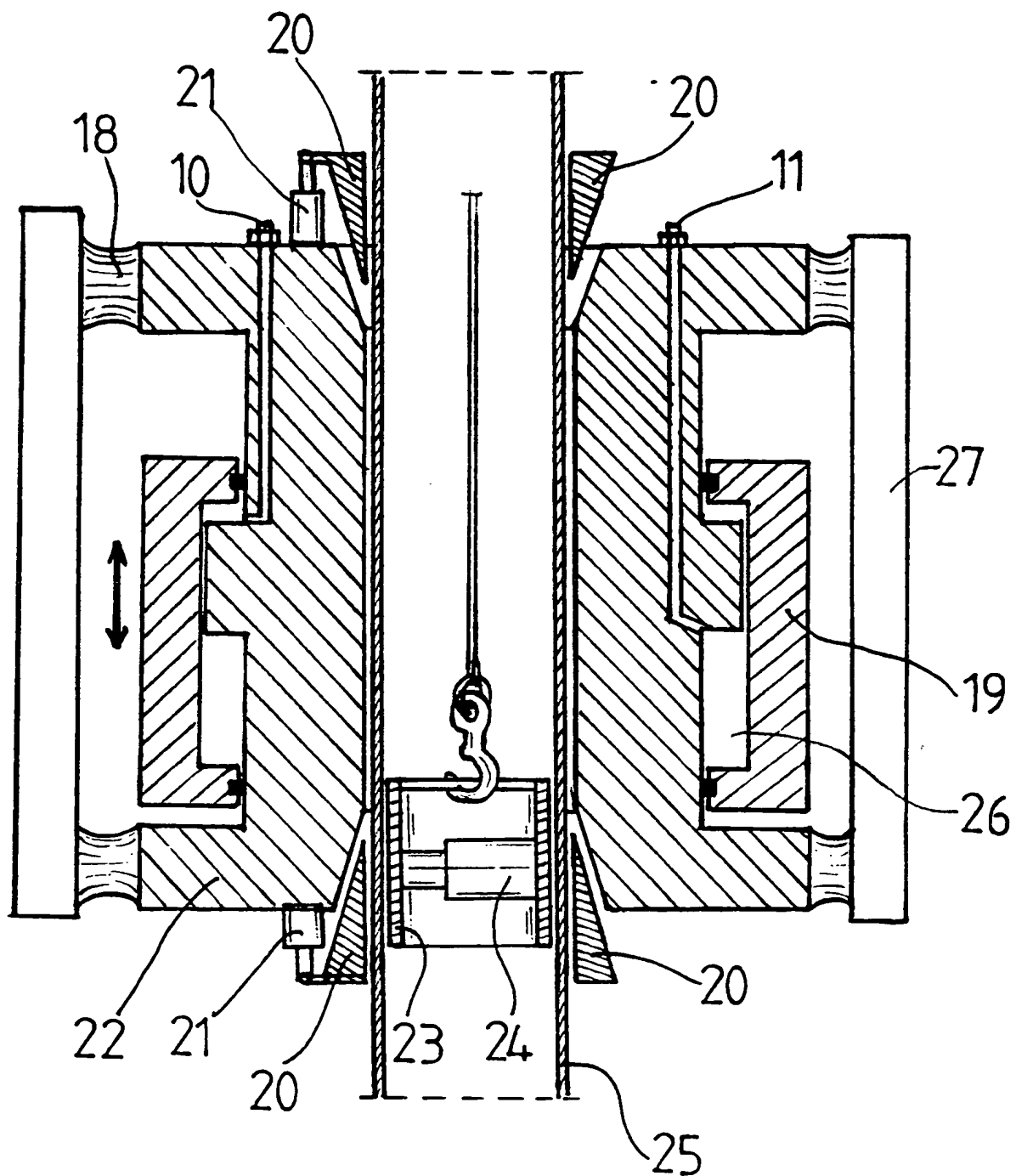


Fig.4

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 96/00425

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
IPC6: B25D 9/04, B25D 17/24, E21B 7/20, E02D 7/10 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
IPC6: B25D, E21B, E21C, E02D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4026193 A (P.B. OLMSTED), 31 May 1977 (31.05.77), figure 1	1-3
Y	--	4-9
Y	Derwent's abstract, No 87-141896/20, week 8720, ABSTRACT OF SU, 1260177 (NIIMOSSTROI RES INS), 30 Sept 1986 (30.09.86), figure 2	4-9
A	US 4478293 A (W. WEILENMANN ET AL), 23 October 1984 (23.10.84), figure 2	4
	-- -----	
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
12 November 1996		14 - 11 - 1996
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer  Henrik Bodin Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

28/10/96

International application No.  
PCT/FI 96/00425

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4026193	31/05/77	DE-A- 2541949	01/04/76
		GB-A- 1492698	23/11/77
		GB-A- 1492699	23/11/77
		GB-A- 1492700	23/11/77
		JP-A- 51056510	18/05/76
		NL-A- 7510977	23/03/76
US-A- 4478293	23/10/84	AU-A- 8440282	16/12/82
		CA-A- 1180578	08/01/85
		DE-A, C- 3122979	05/01/83
		EP-A, B- 0066779	15/12/82
		SE-T3- 0066779	
		JP-C- 1514241	24/08/89
		JP-A- 57211482	25/12/82
		JP-B- 63063358	07/12/88
		SU-A- 1178317	07/09/85

**THIS PAGE BLANK (USPTO)**